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Comment

Interactive comment on “African CO emissions between years 2000 and 2006 as estimated from MOPITT observations” by F. Chevallier et al.

F. Chevallier et al.

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We wish to thank the referee for his helpful comments. We address all the issues he/she has raised in the following. The full review is copied hereafter and our responses are inserted where appropriate.

General Comments: The manuscript entitled African CO emissions between years 2000 and 2006 as estimated from MOPITT observations by Chevallier et al., presents new estimates of CO emissions from Africa biomass burning that were derived using an inversion of the MOPITT CO retrievals. Initial emission estimates are used in a forward run of a new version of the LMDZ CTM to construct a pseudo-distribution of CO in the middle troposphere, uncertainty was added, and a Bayesian synthesis inversion was

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applied to optimize surface CO emissions and provide an estimate of their error. The optimized fluxes were then run in the forward model and compared to independent measurements of surface CO. The results provide a unique estimate of time-varying CO emissions from African biomass burning. I think this manuscript contains two interesting topics: 1) the estimates of CO emissions from biomass burning in Africa, and 2) the simplification of the LMDZ full chemistry model and addition of a framework for the inversion of multiple species. The first is clearly evident in the title, abstract and text. The second topic is not as well presented. The primary topic of this work is to constrain estimates of CO emissions from African biomass burning based upon inversion of remotely sensed CO from MOPITT. It does this well using an approach previously developed and applied by the first author. The description of the process is clearly described. A few comments/questions are provided below. I see the second topic of this manuscript as the new version of the LMDZ-INCA CTM that runs with simplified chemistry. The new version was developed for simultaneous inversions of multiple species, although I think this is somewhat lost in the manuscript and could to be emphasized earlier in the text. Inverting for multiple compounds is still relatively unique and is worthy of additional discussion in the manuscript.

The new chemistry is actually the topic of a specific paper which has been accepted in Atmos. Chem. Phys. Disc. (Pison et al., 2008).

In section 2.3, the authors might should that the model also provides the a priori atmospheric distributions for CH₄ and HCHO.

This is already detailed in section 2.2.

The description of the inversion scheme should explicitly describe how the multi-species inversion (was each species run in series?),

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The following sentence has been inserted in section 2.2 in the paragraph starting with "For technical reasons": "The four chemical tracers are processed together consistently with the simplified chemistry".

and figure or Table of the optimized CH₄, MFC-OH and HCHO could be added.

The details are already given in the last paragraph of section 3.2

This manuscript should fit well in Biogeosciences special issue Carbon cycling in the Sub-Saharan Africa. This is a very good paper I recommend publication after consideration to the comments listed below.

Specific Comments:

P. 3847, l. 15-20. The work requires CO fire emissions over the period 2000- 2006. The data in Van der Werf et al. extends through 2004 and EDGAR 32FT2000 through 2002. How were the priors for 2005 and 2006 estimated?

GFEDv2 has been updated until year 2007 (<http://www.geo.vu.nl/~gwerf/GFED/data/>). We use EDGAR without interannual variations.

P. 3848, section 2.1. Previous studies have shown that model results can be quite sensitive to the meteorology. How was this error estimated and accounted for?

As described in the last paragraph of section 2.3, the model error is arbitrarily set to 50% of the instantaneous concentration values.

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How does the model parameterize vertical mixing? Could the inversion bias emissions because the MOPITT retrieval is most sensitive at 700 to 350 mb and rather insensitive to the surface?

LMDZ is a full general circulation model (section 2.1). Its transport parameterizations accounts for large scale advection, boundary layer turbulence and moist convection.

P.3851, l.,19-22. Does the model also generate a distribution of CH₄, OH and HCHO?

Yes (see section 2.1).

P.3856, section 3.2, Figure 3. The MOPITT averaging kernel must have been applied to the model CO vertical profiles but I do not see it mentioned.

The information was given in section 2.3, but was not repeated afterwards. We added it explicitly in the legends of Figures 3 and 4.

P.3856, Figure 3. The optimized fluxes improved model to observations by 25%. What is the difference between the a posteriori CO distribution and MOPITT?

The numeric values are given in Figure 4 for subcontinental areas. The differences are about of a few ppb.

P. 3858. The conclusions should include a short summary on how the errors in the optimized emissions could be reduced and what is needed to better reproduce the observations.

This was already the topic of the last paragraph of the conclusion section. We added an extra paragraph before it to comment on the prior errors: "The errors of the prior emissions have been empirically assigned. The inversion results would clearly benefit from a rigorous investigation of the statistical characteristics of the emission inventory errors. However, such a task will be complicated by the high variability of the CO emissions in space and in time, that makes the error distributions diverge from normality".

Technical Corrections:

Abstract I 4-5. What is a variation scheme?

We removed the adjective and inserted the sentence "It is based on a variational principle".

P. 3847, I. 23-26: The sentence beginning: In addition to these two information pieces, should end at ...radical OH. The rest of the sentence is unclear.

The sentence now reads: "The inversion system gathers three other information types: methyl-chloroform (MCF) surface measurements to constrain the concentrations of the hydroxyl radical OH, a global chemistry-transport model and the error statistics associated to each information piece".

P. 3847, I.6. Provide a reference for the CO budget.

We added Ciaï et al. from the same special issue.

P. 3848, I. 3-5. I suggest this sentence be rewritten as Carbon monoxide is produced from the combustion of fossil fuels and biomass and from the oxidation of hydrocarbons.

We did it.

P. 3853, I. 15. Particles per billion or particles per million should be part per billion or part per million.

We did it.

P.3856, I.11. Why are the observations (uncertain)?

We removed "(uncertain)" and added a sentence at the end of the paragraph: "Third, the assigned observations errors are large".

P. 3858. I.19. help constraining should be help constrain.

We did it.

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Discussion Paper

S2244

